REMARKS

Reconsideration and allowance of the instant application are respectfully requested in view of the following remarks.

Status of the Claims

Claims 1-12 were originally filed. Claims 13-30 were previously added in a preliminary amendment.

Currently, claims 1-5, 7-10 and 12-30 have been cancelled, claims 6 and 11 have been amended, and claims 31 and 32 have been added.

Support for the amendments to claim 6 is found in: paragraph 37 (a width of 10mm to 150mm); paragraph 41 (a length of 1m to 300m); paragraph 29 (EFG process, a string ribbon process and a dentritic web process); paragraph 44 (a first step for loading said silicon substrate into a first vacuum chamber, in which the pressure is controlled at least once; said first vacuum chamber is provided in separate with a chemical vapor deposition device); paragraph 49, 51, 52 and Figures 2 and 4 (continuously); paragraph 55, see page 7, lines 2-4 (semi-continuously); paragraph 44 (a second step for loading said silicon substrate into a second vacuum chamber, in which the pressure is controlled at least once; said second vacuum chamber is provided in separate with a chemical vapor deposition device);

Support for the amendments to claim 11 is found in paragraph 50 (in a drum with diameter of 50mm or more).

Support for new claim 31 is found in paragraph 45 and Figure 3 (air sealing system made from a rubber damper comprising two rubber plates with overlapped portion).

Support for new claim 32 is found in paragraph 53 (said chemical vapor deposition process is a hot filament chemical vapor deposition process, where the filaments are disposed in right angle to the longitudinal direction of the silicon substrates).

Therefore, no new matter has been added.

<u>35 U.S.C. § 102 Rejection</u>

Claims 1, 3-6, 8-10, and 15 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,607,560 to Hirabayashi (hereinafter referred to as "Hirabayashi"). Applicant respectfully traverses.

Independent claim 6 has been amended to include all the elements of dependent claims 7, 9 and 11. Dependent claims 7, 9

and 11 were not rejected under 35 U.S.C. § 102 as being anticipated by Hirabayashi.

Therefore, the instant § 102 anticipation rejection over Hirabayashi should be removed as moot in view of the current amendments.

35 U.S.C. § 103 Rejection

Claims 2, 7, 11-14 and 16-30 were rejected under 35 U.S.C. §103(a) as being obvious over Hirabayashi. Applicant respectfully traverses.

Hirabayashi teaches forming a diamond crystal on a substrate by a sputtering process using high frequency energy. See Column 2, Lines 47-51. Hirabayashi teaches that it is possible to add boron gas for forming p-types semi-conductor diamond. See Column 3, line 39-43. Then, Hirabayashi discloses indirectly that the silicon substrate can be coated with electrically conductive diamond. Hirabayashi discloses a sputtering apparatus, for forming the diamond crystal, in which the substrate is held inside (see Column 3, line 18-21, Fig. 1) and the forming time of diamond crystal is set to 5 hours. See Column 5, lines 15-16.

On the one hand, the object of Hirabayashi's invention is to provide a method that can form the diamond crystal in large area. See Column 2, lines 24-28.

On the other hand, Hirabayashi discloses only a <u>3 inch in diameter, 400 μm thick silicon</u> single crystal as a substrate for forming a diamond crystal. See Column 5, lines 13-14. Applicant agrees with the Examiner that Hirabayashi's invention discloses a silicon substrate having a thickness less than 500 μm. However, 3 inches in <u>diameter</u> can only mean that the silicon substate has a disk shape and, unless any other particular characteristic of the substrate is given, it can be concluded that it is a 3 inch (76.2 mm) diameter single-crystal silicon wafer. Silicon wafers of disk shape are made by slicing a cylindrical single-crystal silicon ingot with a fretsaw, a well known method to produce silicon wafers in the semi-conductor industry.

The process for forming silicon ingot is known as Czochralki growth in which a seed crystal is pulled from a melt silicon bath. Czochralki growth clearly differs to the plate-like crystal growth process used in the instant invention. Czochralki growth produces silicon in the for of rods or ingots. Plate-like crystal growth, such as EFG, string ribbon and dendritic web, produces silicon substrate as plates or films. Actually, typical commercially available silicon wafers are of 8 inches (200mm) in

diameter and the largest available in the market are 300mm in diameter. Accordingly, the surface area that can be provided by a silicon wafer is quite small compared with the present invention. The present invention intends to provide a diamond-coated silicon having a large surface area, such as <u>one square meter</u> (see paragraph 9).

Hirabayashi does not teach or suggest the process of coating diamond to a silicon substrate, where the silicon substrate has a large surface area, a width of 10mm to 150mm (see paragraph 37), and a length of 1 to 300 m (see paragraph 41); which is characteristic of a silicon substrate produced by the plate-like crystal growth process, as claimed in the instant invention.

Hirabayashi does not teach coating such a long and thin silicon substrate continuously or semi-continuously with electrically conductive diamond. Once Hirabayashi teaches that the 3 inches silicon wafer is held inside the sputtering apparatus for 5 hours, it is clear that the coating method is a <u>batch process</u>. In the present invention, the long silicon substrates are <u>continuously</u> or <u>semi-continuously</u> fed into the chemical vapor deposition ("CVD") device and are <u>continuously</u> coated with diamond while moving toward one side to another side of the CVD device. The diamond coated silicon is also <u>continuously</u> or <u>semi-continuously</u> discharged from the coating

process (see Fig. 2, Fig. 4 and Fig. 5). The efficiency and advantage into coating larger areas by such continuous or semi-continuous method is clear compared with Hirabayashi or any other conventional batch process for diamond-coating silicon wafers.

Hirabayashi clearly does not obviate the independent claim, claim 6. Although plate-like crystal growth process is a known method to the skilled artisan, for production of silicon used in solar cells for example, the combination of such known method and the teaching of Hirabayashi does not result in the present invention of producing continuously or semi-continuously the large area diamond-coated silicon which will contribute to the mass production of diamond electrodes (see paragraphs 49, 51 and 52).

Further elements of independent claim 6 include; a step for loading long and thin silicon substrate and a step for unloading diamond-coated silicon into/from a vacuum chamber provided separate from the CVD device and where the pressure is controlled at least once (see paragraph 44).

Coating the apparatus in a single compartment chamber such as disclosed in Hirabayashi's Figure 1 repeats the following steps of vacuuming, feeding reaction gas and heating the whole chamber up to 700°C (see column 5, lines 10-13) for each batch.

Also, after coating 3 inches of silicon substrate for 5 hours, as required in Hirabayashi, the temperature must decrease, thus, vacuuming the reaction gas and bringing the whole chamber to ambient temperature is repeated for discharging each 3 inches of coated silicon made by Hirabayashi. Such batch procedure obviously results in enormous loss of electrical power and labor work.

In the present invention, once the diamond coating is continuously conducted, the coating temperature in the CVD coating chamber is kept constant (see paragraph 55, last 3 sentences, see also Figure 6). The CVD device where the diamond coating takes place is kept at steady state condition. See Paragraph 55. The load of long and thin silicon substrate and unload of diamond-coated silicon substrate are made at different places from diamond coating places. In Figure 2, the loading place corresponds to the vacuum chamber 30 and the unloading place corresponds to the vacuum chamber 31. See paragraph 44. In Figure 4, the loading place corresponds to the drum boxes 40 and the unloading place corresponds to the drum boxes 42. See paragraph 51. Also, the load chamber 52 and the unload chamber 53 are illustrated in Figure 5. See paragraph 53. At the load and unload chambers, which are vacuum chambers separated from the CVD device where the diamond coating takes place, the pressure is controlled at least once for the purpose of isolating CVD coating

atmosphere from room atmosphere. In Figure 2, the pressure control is made more than once and gradually at the partitions a, b, c of chambers 30 and 31.

The pressure is changed just in the smaller volume of the load and unload vacuum chambers, making unnecessary to change the whole pressure of the CVD chamber such as in the conventional batch process. See paragraph 55, page 7.

Additionally, with the use of hot filament CVD (see new claim 32), once the filament temperature can be kept constant, longer filament lifetime is achieved while loading and unloading the silicon substrate. See paragraph 55, last three sentences.

Independent claim 6 is directed to a method of manufacturing diamond coated-silicon comprising the steps of:

(a) manufacturing a silicon substrate having a thickness of 500 μm or less, a width of 10mm to 150mm, and a length of 1m to 300m, by a plate-like crystal growth process, said plate-like crystal growth process selected from the group consisting of an EFG process, a string ribbon process and a dendritic web process;

(d) loading said silicon substrate into a first vacuum chamber, where the pressure is controlled at least once by said

first vacuum chamber, and said first vacuum chamber is separate from a chemical vapor deposition device;

(e) coating the manufactured silicon substrate at least partially with electrically conductive diamond continuously or semi-continuously by chemical vapor deposition process by loading said silicon substrate into a chemical vapor deposition device;

(f) loading said silicon substrate into a second vacuum chamber, where the pressure is controlled at least once by said second vacuum chamber, and said second vacuum chamber is separate from a chemical vapor deposition device;

(g) unloading the diamond coated silicon substrate from said second vacuum chamber.

In sum, such features of a method for <u>continuously</u> or <u>semi-continuously</u> coating long and thin silicon substrate with conductive diamond are not obviated by the combination of Hirabayashi's invention with a known method for production of silicon substrate.

Dependent claim 31 depends from and thus includes all the elements of independent claim 6. However, dependent claim 31 adds the elements of an <u>air sealing system</u> for loading and unloading continuously the long and thin silicon substrate, comprising two overlapped rubber plates forming a dumper. The

pressure difference between partitions allows a self-sealing of the continuous and long and thin silicon substrate between the overlapped rubber plates (see paragraph 45). Such self-sealing system is specific for loading and unloading long and thin silicon substrate and is not obviated by the case of coating a silicon wafer which has limited circular shape.

Hirabayashi does not teach or suggest the self-sealing system with the rubber damper, thus, dependent claim 31 is clearly novel. Also, dependent claim 31 is not achieved by combining Hirabayashi and any known method for producing diamond-coated silicon substrate.

Dependent claim 11 depends from and thus includes all the elements of independent claim 6. However, dependent claim 11 adds the elements of winding coated or uncoated diamond long silicon substrate. The Examiner pointed out that the winding techniques are well known to produce and store continuous length coated product. However, the claim has been amended by adding limiting features allowing to clear the obviousness pointed out by the Examiner.

It is in the range of skilled artisan's knowledge that silicon substrate is fragile and cannot be wound. Examiner is kindly invited to point to previous art which shows a teaching

where the silicon substrate has been wound around a drum, as in amended dependent claim 11.

Specific thickness of silicon substrate of less than 500 μm and specific winding diameter larger than 50mm allowed for the winding operation of the instant invention. Additionaly, the correct placing of diamond-coated face to the outward face in the winding process allows the winding of diamond coated silicon without cracks. See paragraph 50.

Therefore, dependent claim 11 is not obviated from the combination of the knowledge of one skilled in the art and the teachings of Hirabayashi.

Dependent claim 32 depends from and thus includes all the elements of independent claim 6. However, dependent claim 32 adds the element of using hot filament CVD with the filaments being positioned at a right angle to the longitudinal direction of the silicon substrate. The positioning of the filaments at a right angle to the longitudinal direction of the long silicon substrate allows the use of a shorter filament length. Shorter lengths avoid the slacking of filament during the high temperature operation such as 2000°C. See paragraph 53.

Hirabayashi does not teach or suggest anything about using a shorter filament length, thus, dependent claim 32 is not obviated from combining Hirabayashi with a known method of producing silicon substrate.

Therefore, independent claim 6 and dependent claims 11, 31 and 32 should be allowed.

Conclusion

In view of the foregoing, applicant respectfully requests an early notice of allowance.

Respectfully submitted,

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